Chapter 12

PHOTOTHERMAL CALORIMETRY: SIMULTANEOUS MEASUREMENTS OF SPECIFIC HEAT AND THERMAL CONDUCTIVITY

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1. Introduction

The photothermal techniques are based on the periodic heating induced in an investigated sample by a modulated light source, the sample temperature oscillations being detected using various techniques, such as gas microphone\(^1\), piezoelectric\(^2\), photodeflection\(^3\) and photopyroelectric\(^4\). The photothermal signal, which is characterized by amplitude and phase, depends on the sample thermal as well as optical properties and may thus be used for thermal parameter measurements of the investigated sample.

The photothermal techniques, are a.c. techniques and they allow an adequate signal to noise ratio to be achieved while introducing temperature oscillations on the sample surface of only a few mK. The d.c. temperature variations within the sample induced by the a.c. heating source are also very small. The technique is thus very attractive for the study the behaviour of the thermal parameters in thermotropic liquid crystals in the vicinity of their phase transitions, where the parameters may depend strongly on temperature. Moreover, since under particular experimental conditions one of the photothermal signal channels, the phase channel, depends on only the sample thermal transport properties, the technique may be used to measure simultaneously the specific heat and the thermal conductivity of the sample, thus enabling the investigation of both the static and dynamic critical behaviours associated with the thermal parameters in the vicinity of liquid crystal phase transitions. In this paper we shall review the results which may be obtained in this respect using the gas microphone and photopyroelectric configurations.

2. Gas Microphone Configuration

In the gas microphone configuration the sample is contained in an air tight volume where a microphone is also contained (Fig.1).
Fig. 1. Photoacoustic cell configuration.

Fig. 2. Photoacoustic signal amplitude over the smectic A - nematic phase transition in 9CB.

Fig. 3. Photoacoustic signal phase over the smectic A - nematic phase transition in 9CB.